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AN EVALUATION OF PINE BUTTERFLY[1] POPULATIONS ON THE BOISE, PAYETTE, AND SALMON NATIONAL FORESTS 1984

by

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ABSTRACT

Pine butterfly defoliation and populations decreased in 1984. Ponderosa pine occupying 2,800 acres on the Boise National Forest was defoliated by the pine butterfly. Population evaluations indicate that defoliation in 1985 will continue to be localized with intensity predicted to range from negligible to light.

INTRODUCTION

Pine butterfly, Neophasia menapia (Felder & Felder), occurs in ponderosa pine stands across the western United States (Cole 1971). Populations of this insect and coincident feeding occasionally reach high levels resulting in severe tree defoliation. The earliest documented defoliation by this insect was in 1882 near Spokane, Washington where nearly all foliage had been stripped from host trees (Hopkins 1907). Outbreaks in southern Idaho have been documented in 1898 in the Boise Basin; in 1907 near Alpha, Idaho; in 1922 around the Payette Lakes (Evenden 1940); and in 1953 between Deadwood Reservoir

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and the Middle Fork of the Boise River [Cole 1956]. The most recent pine butterfly infestation in southern Idaho began in 1981 when ponderosa pines in a small 500 to 600 acre area south of Dry Buck Summit on the Boise National Forest were defoliated [Thier 1982]. In 1982, defoliation around Dry Buck Summit intensified, and a new area of defoliation was discovered on state and private lands north of Cascade, Idaho [Thier 1983]. In 1983 defoliation decreased at Dry Buck Summit and intensified on state and private lands north of Cascade, Idaho. In addition approximately 80 acres of defoliation were discovered on the Salmon National Forest in the Owl Creek drainage in 1983 [Thier et al. 1984].

Effects of defoliation by pine butterfly have received little attention and reports are somewhat contradictory. Evenden [1940] reported that 26 percent of the trees defoliated during the Payette Lakes outbreak in 1922 died. Of this mortality 12 percent was directly attributed to defoliation by pine butterfly and 14 percent to bark beetle attack. He believed that the tree's weakened condition, due to defoliation, was sufficient to attract bark beetles to them. In contrast, Cole [1966] reported that less than two percent of the defoliated trees died following the 1952-54 outbreak in the Deadwood area. Both authors [Cole 1966, Evenden 1940] examined mean annual radial growth and found similar results; a reduction of expected normal growth increment by approximately 39 percent.

In this evaluation we report on the current outbreak in southern Idaho. Data concerning population status, effects of predation and parasitism, and defoliation predictions are presented.

METHODS

Population Status

Detection--As part of the annual regional insect surveillance program, aerial surveys were conducted during the summer of 1984 to monitor and record pine butterfly defoliation.

Population Evaluation--To evaluate the 1984 population status, we employed the egg sampling techniques outlined by Bousfield and Dewey [1972]. Six five-inch apical twigs were collected at midcrown from each of ten trees at each evaluation site and taken to the laboratory for examination.

Selection of evaluation sites was based on areas sampled during previous assessments [Thier et al. 1984] and knowledge of existing pine butterfly activity. We sampled a total of 17 sites on the Boise, Payette, and Salmon National Forests. General location of the sites on the Boise, Payette, and Salmon National Forests are shown in Figure 1. Specific site locations are documented by Thier et al [1984]. One previously visited site, Anderson Creek, was not visited in 1984 but is included in Tables 1, 2, and 3 for future reference.

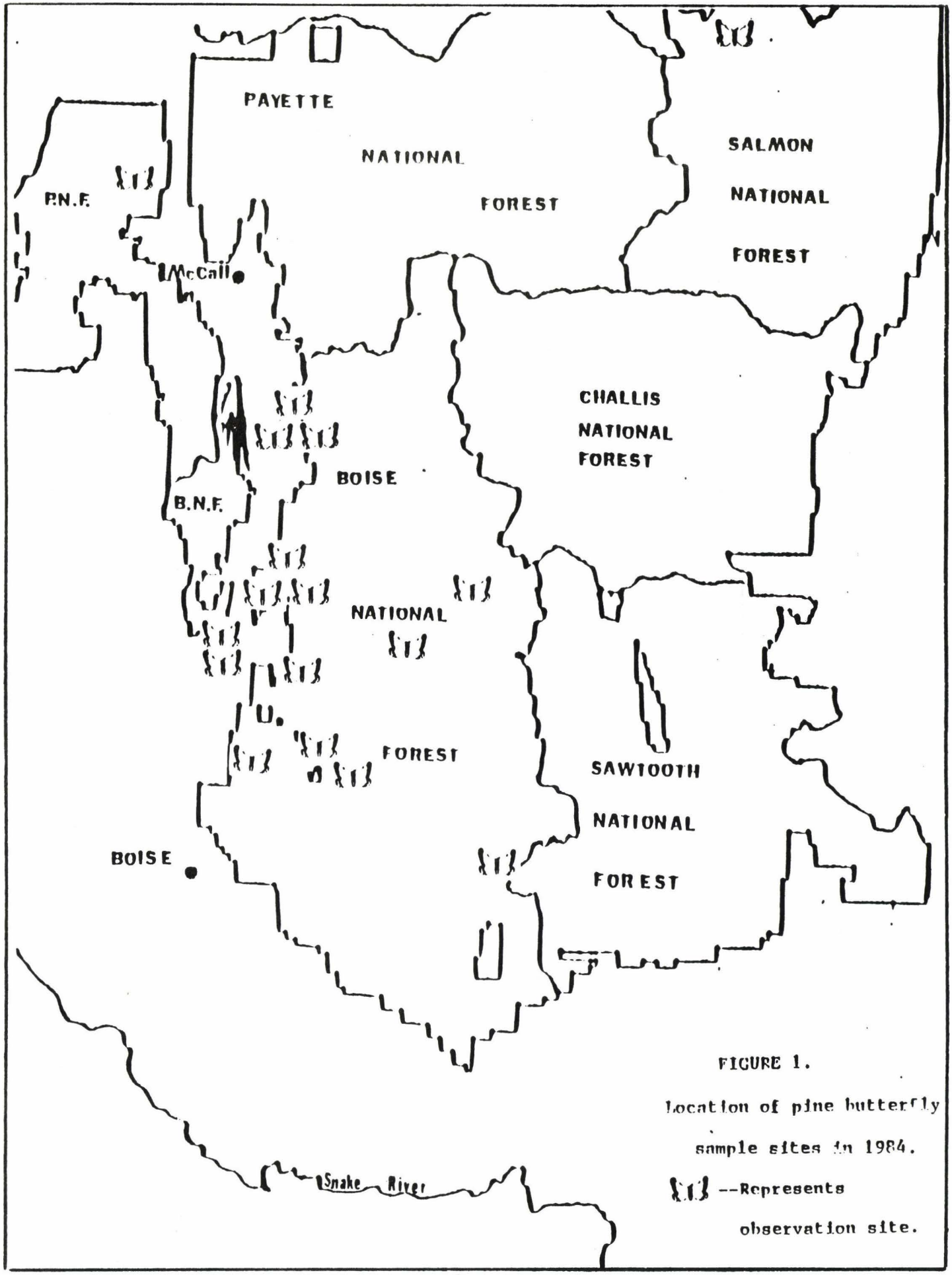

FIGURE 1.

location of pine butterfly sample sites in 1984.

--Represents observation site.

In the laboratory we examined twigs for pine butterfly eggs. Eggs were counted, categorized as viable or nonviable, and the average number of viable eggs per twig computed. Values were then compared with previous evaluations [Thier 1982, 1983, Thier et al. 1984] to determine relative change in size of pine butterfly populations.

Predation--During lab evaluations nonviable eggs, assumed to result from predation, were also counted. Distinction between viable and nonviable eggs was based on color. If egg color was other than the normal light green it was considered to have been affected by predators [Bousfield and Dewey 1972]. We used these values to compute the mean number of eggs per twig destroyed by predation and the percent egg predation. These values indicate the degree of natural predation upon the egg stage of the pine butterfly population.

Parasitism--In early August we determined pupal parasitism rates for the Pearsol Creek and State Plot #16 evaluation sites [Fig. 1]. We reared 42 pupae from Pearsol Creek and over 220 pupae from State Plot #16 to identify the parasite[s], to compute the percent parasitism and to compute the percent emergence of adult pine butterflies.

Predicted Defoliation

To predict 1985 defoliation levels we used the methods developed by Bousfield and Dewey [1972]. When we gathered eggs at each evaluation site we computed the percentage of trees with defoliation. This was based on the observed defoliation of 20 host trees around each site. Using this defoliation information and viable egg averages computed earlier, the following equation was used to generate defoliation indices for 1985:

$$Y = -0.0659 + 0.0141 [X 1] + 0.02 [X 2], \text{ where}$$

Y = predicted defoliation index

X 1= mean number of viable eggs/five-inch twig

X 2= percentage of trees with current defoliation

So that the defoliation index [Y] is useful in quantifying predicted defoliation, it is converted to predicted percent defoliation and then, for ease of discussion, to defoliation category by interpolation in the following table:

Defoliation Index	Predicted Defoliation [%]	Predicted Defoliation Category
0	0	Negligible
1	25	Light
2	50	Moderate
3	75	Heavy
4	100	Severe

Finally, we compared 1984 and 1985 calculated defoliation indices to follow defoliation index trends.

RESULTS AND DISCUSSION

Population Status

Detection--Approximately 2,800 acres of light to moderate ponderosa pine defoliation was recorded in 1984. All defoliation was on state and private lands in the pine type east of Cascade Reservoir (Knapp 1985). This compares with approximately 16,280 acres of light to heavy defoliation seen in 1983 on and around the Boise and the Salmon National Forests (Thier et al. 1984).

For the first time since 1980 defoliation was not observed at Dry Buck Summit on the Boise National Forest. Defoliation detected on the Salmon National Forest in the Owl Creek drainage (Thier et al. 1984) in 1983 was not reported in 1984.

Population Evaluation--Viable egg counts for sample sites ranged from 0 to 1.22 per 5 inch twig (Table 1). The highest viable egg count, averaging 1.22 per 5 inch twig, was from the evaluation site at Dry Buck Summit #1 on the Boise National Forest northwest of Banks, Idaho .

At six locations no pine butterfly eggs were collected. These sites were: Bear Run, Little Cayuse Creek, Station Creek, and West Fork Six Mile Creek on the Boise National Forest, along with Railroad Saddle on the Payette National Forest.

We determined the relative change in the size of the resident pine butterfly populations at evaluation sites sampled in previous years by comparing the mean number of viable eggs in 1984 with previous year's data (Thier et al. 1984). The most dramatic decreases in egg deposition occurred on the Boise National Forest at Grandjean Junction, Lick Creek, Little Pearsol Creek, Pearsol Creek, State Plot #16 and at Colson Creek on the Salmon National Forest. Viable egg counts for these sites averaged 0.42 eggs/5 inch twig. This compares with an average of 16.11 eggs/5 inch twig for the same six sites in 1983.

Comparisons of 1983 and 1984 counts at most other sites also show reductions which suggest a general decline in the overall population of pine butterflies on all three National Forests.

Predation--Evaluation sites are ranked in Table 2 according to degree of egg predation. Some predation occurred at 11 of the 17 evaluation sites and ranged from 88.54 percent at Scriver Creek to zero at a number of sites.

Table 1. Mean number of viable pine butterfly eggs per five-inch twig - 1981, 1982, 1983, 1984.

Evaluation Site	Mean No. Viable Eggs/Five-Inch Twig 1981	1982	1983	1984
Boise N.F.				
Bear Run	0.00	0.17	0.00	0.00
Cow Creek	0.37	0.00	0.00	0.22
Dry Buck Summit #1	33.67	10.52	0.31	1.22
Dry Buck Summit #2	N.S.[1]	13.40	0.58	0.77
Grandjean Junction	N.S.	N.S.	10.65	0.60
Harris Creek Summit	0.27	0.65	1.06	0.32
Lick Creek	0.10	2.30	7.30	0.30
Little Cayuse Creek	N.S.	N.S.	1.35	0.00
Little Pearsol Creek	0.40	4.37	20.58	0.93
North Fork Rabbit Creek	0.13	0.72	0.42	0.07
Pearsol Creek	2.35	19.73	16.47	0.10
Scriver Creek	0.29	0.00	0.00	0.03
State Plot #16	N.S.	N.S.	29.98	0.35
Station Creek	0.20	0.15	0.00	0.00
West Fork Six Mile Creek	0.00	0.47	0.13	0.00
Payette N.F.				
Anderson Creek	N.S.	6.83	1.23	N.S.
Railroad Saddle	0.00	0.20	0.38	0.00
Salmon N.F.				
Colson Creek	N.S.	2.77	11.68	0.25

[1] N.S. - not sampled

Table 2. Pine butterfly egg predation on the Boise, Payette and Salmon National Forests - 1984.

Evaluation Site	Mean Number of Eggs/Five-Inch Twig: Total Eggs	Destroyed by Predation	Percent Egg Predation
Boise N.F.			
Scriver Creek	0.32	0.28	88.54
Pearsol Creek	0.70	0.60	85.71
Lick Creek	0.95	0.65	68.42
State Plot #16	3.53	2.38	67.50
Little Pearsol Creek	2.50	1.57	62.67
Grandjean Junction	3.60	2.00	55.56
Dry Buck Summit #2	1.15	0.38	33.33
North Fork Rabbit Creek	0.08	0.02	20.83
Harris Creek Summit	0.35	0.03	8.57
Dry Buck Summit #1	1.25	0.03	2.40
Cow Creek	0.22	0	0
Bear Run	0	0	0
Little Cayuse Creek	0	0	0
Station Creek	0	0	0
West Fork Six Mile Creek	0	0	0
Payette N.F.			
Anderson Creek	N.S.[1]	N.S.	N.S.
Railroad Saddle	0	0	0
Salmon N.F.			
Colson Creek	1.26	1.36	84.36

[1] N.S. - not sampled

The importance of egg predation in regulating the pine butterfly is unknown (Cole 1956). Highest egg predation levels in 1984 were found at Scriver Creek, Grandjean Junction, Lick Creek, Little Pearsol Creek, Pearsol Creek, State Plot #16, and Colson Creek.

Parasitism--Emergence of adult pine butterflies from pupae collected at Pearsol Creek and State Plot #16 was 9.5 percent and 5.0 percent respectively. Theronia atalantae fulvescens (Cresson), an ichneumonid wasp, was the most important parasite identified from both sites. Of the pine butterfly pupae we examined from State Plot #16 and from Pearsol Creek 86.8 percent and 59.5 percent respectively were parasitized by this wasp.

We agree with Cole (1956, 1971) that T. atalantae represents an important natural control of pine butterfly. Note that with the high level of parasitism at Pearsol Creek the pine butterfly egg counts are down (Table 1). This inverse relationship is expected as T. atalantae is indirectly reducing the number of egg laying adult pine butterflies. We further agree with Cole (1971), based on our parasite evaluations at Pearsol Creek and State Plot #16, and those made at Dry Buck Summit in 1983 (Thier et al. 1984), that the parasite population buildup lags one to two years behind the buildup of pine butterfly. Since Cole (1956, 1971) indicates that T. atalantae plays an important role in reducing outbreaks of pine butterfly, and the wasp is presently an important parasite at Pearsol Creek and State Plot #16, we suspect that it will be found associated with and effective in reducing, pine butterfly populations at other evaluation sites.

We recovered four specimens of an unidentified parasitic fly from pupae colleced at Pearsol Creek. It was associated with mortality in 4.8 percent of the pine butterfly pupae collected from that site. The same parasitic fly was found at State Plot #16 where it was associated with mortality in 1.8 percent of the pine butterfly pupae sampled.

No reason was apparent for the lack of adult emergence from 26.2 percent of the pupae from Pearsol Creek and 6.4 percent of the pupae from State Plot #16.

Predicted Defoliation

Predicted 1985 defoliation levels range from negligible, predicted for 15 of the evaluation sites, to light predicted for 2 of the total 17 evaluation sites (Table 3). The light defoliation predictions were made for Pearsol Creek and Scriver Creek on the Boise National Forest.

Lastly, by comparing the 1984 and 1985 defoliation indices (Table 3), we developed defoliation index trends. An upward trend of defoliation is suggested for three areas: Little Cayuse Creek, North Fork Rabbit Creek, and Scriver Creek. None appear important because of the small magnitude of change. The increase in predicted defoliation is primarily due to the defoliation observed at these sites in 1984. These evaluation sites

Table 3. Potential defoliation by pine butterfly on the Boise, Payette and Salmon National Forests in 1985.

Evaluation Site	1984 Defoliation Index	1985 Predicted Defoliation Index	1985 Predicted Percent Defoliation	1985 Defoliation Category	Defoliation Index Trend[1]
Boise N.F.					
Bear Run	0.6	0	0	Negligible	-
Cow Creek	0.1	0.1	3	Negligible	0
Dry Buck Summit #1	1.4	0.1	3	Negligible	-
Dry Buck Summit #2	1.0	0.1	3	Negligible	-
Grandjean Junction	0.9	0.1	3	Negligible	-
Harris Creek Summit	0.1	0.1	3	Negligible	0
Lick Creek	0.7	0.3	8	Negligible	-
Little Cayuse Creek	0	0.5	13	Negligible	+
Little Pearsol	1.1	0.1	3	Negligible	-
North Fork Rabbit Creek	0.1	0.4	10	Negligible	+
Pearsol Creek	2.2	1.1	29	Light	-
Scriver Creek	0.2	0.7	18	Light	+
State Plot #16	2.0	0.4	10	Negligible	-
Station Creek	0.1	0	0	Negligible	-
West Fork Six Mile Creek	0.1	0	0	Negligible	-
Payette N.F.					
Anderson Creek	0.8	N.S.[2]	N.S.	N.S.	
Railroad Saddle	0.9	0	0	Negligible	-
Salmon N.F.					
Colson Creek	0.3	0.1	3	Negligible	-

[1] Trend: 0 static, + increasing, - decreasing. Established from comparison of 1984, 1985 defoliation indices.

[2] N.S. - not sampled

may sustain increased defoliation in the future if upward trends continue and natural controls do not become limiting.

A downward trend of defoliation indices was noted at another twelve evaluation sites (Table 3) but Grandjean Junction, Lick Creek, Little Pearsol Creek, Pearsol Creek, and State Plot #16 on the Boise National Forest and Colson Creek on the Salmon National Forest appear important because of the magnitude of change. This trend indicates a decrease in defoliation and perhaps a population collapse. The trend was static at Cow Creek and Harris Creek Summit.

MANAGEMENT ALTERNATIVES

Maintain Present Management

Under this alternative, infestations will continue until they decline naturally. Outbreaks usually persist two to five years before they are controlled by natural enemies which are presently increasing in several areas - tree mortality and reduced growth may occur. In the 1920's defoliation alone resulted in 12 percent mortality (Evenden 1940) but in the 1950's no mortality due to defoliation alone occurred (Cole 1966). Trees weakened by defoliation may fall prey to bark beetles. The following quote best summarizes the impact of pine butterfly defoliation as recorded by Hopkins (1907):

> "Evidently, while it (pine butterfly) appears at irregular intervals in such vast swarms as to attract general attention and vast areas of pine are often defoliated by the larvae, its natural enemies prevent the continuance of its depredations in any one locality long enough to be independently destructive to the timber; yet it appears that the weakened condition, even a slight defoliation, is sufficient in some cases to attract certain of the destructive bark beetles..."

Losses to bark beetles have ranged from 1.3 to 14.0 percent (Evenden 1940, Cole 1966). In both the 1920's and 1950's outbreaks, a 39 percent reduction in normal growth was measured (Evenden 1940, Cole 1966).

Silvicultural Management

Evenden (1940) stated that tree vigor, prior to defoliation, was important in a tree's ability to recover from defoliation. If tree vigor is maximized through stand management, it then follows that insect and disease impacts will be minimized. We speculate that prescriptions that favor stand species diversity and maximize tree vigor will minimize the effects of defoliation. This is a long-term action alternative and will do little to suppress the current outbreak.

Direct Suppression

The Enviromental Protection Agency registers only one insecticide, the bacterium Bacillus thuringiensis Berliner, for pine butterfly suppression. This insecticide kills the larvae of moths and butterflies without causing direct adverse effects on other plants or animals. Testing conducted in 1973 showed B. thuringiensis to be 92 percent effective in reducing larval pine butterfly populations when applied at the currently registered dosage rate [Dewey et al. 1973]. Its effectiveness has been inconsistent when used operationally on other forest pests. If B. thuringiensis were applied effectively, we expect the synergistic effect of naturally occurring parasites, predators, and the applied bacterium to be extremely effective in suppressing the pine butterfly.

RECOMMENDATIONS

The "maintain present management" alternative is recommended for the current outbreak. Based on the relative decrease in the size of resident pine butterfly populations and the increase in the predator/parasite complex at Pearsol Creek and State Plot #16, the outbreak populations at these two sites should soon collapse. Butterfly populations at other evaluation sites may expand, but within two to three years will probably also collapse due to natural controls. Thus we do not see significant gain from direct suppression at this time. If significant numbers of trees appear to be threatened a suppression project may be considered. If trees are killed then a sanitation-salvage operation may be considered if economically and environmentally feasible. We further recommend the "silvicultural management" altenative be considered as a long term management strategy.

Due to the overall decline in pine butterfly populations we recommend a reduction in the number of observation sites to be visited in 1985. At least seven sites should be dropped including; Bear Run, Cow Creek, North Fork Rabbit Creek, Scriver Creek, Station Creek, West Fork Six Mile Creek, and Railroad Saddle. These sites have shown consistantly low viable egg counts over the last 2-3 years. New observation sites should be added where necessary if pine butterfly flights or defoliation is observed in August of 1985.

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